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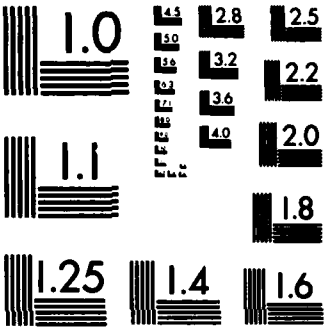

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HOSPITALIZATIONS FOR ACCIDENTS AND INJURIES IN THE U.S. NAVY
II. EXTERNAL CAUSE OF ACCIDENT, DUTY STATION ASSIGNMENT, AND LEVEL OF SENIORITY

J. C. HELMKAMP
C. M. BONE

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NAVAL HEALTH RESEARCH CENTER
P.O. BOX 85122
SAN DIEGO, CALIFORNIA 92138-9174

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND

HOSPITALIZATIONS FOR ACCIDENTS AND INJURIES IN THE U.S. NAVY

II. EXTERNAL CAUSE OF ACCIDENT, DUTY STATION ASSIGNMENT, AND LEVEL OF SENIORITY

LCDR James C. Helmkamp, MSC, USN

and

Craig M. Bone, B.S.

Environmental Medicine Department

Naval Health Research Center

P. O. Box 85122

San Diego, California 92138-9174

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SUMMARY

Problem

Accidents are the leading cause of death and disability among men under age 35, claiming more lives than all other causes combined. In order to provide a basis for focusing accident prevention programs and medical resources where they are most needed, it is necessary to obtain a better understanding of the major causes of accidental injuries and the environments in which they occur.

Objective

The objectives of this study were to analyze accidental injury hospitalization rates for major operational, administrative, tactical, and support duty stations in the Navy in their relation to the specific external cause of the accident and to the hospitalized individual's level of seniority.

Approach

The study included all Naval hospital admissions of male enlisted personnel for accidents or injuries during the period 1977-1979 (N = 21,925). Duty station, pay grade, external cause of injury, and duty status (on-duty, off-duty, or duty status not specified) were extracted from each patient's hospitalization record. Injury rates, specific for duty status and external cause, were compared among personnel assigned to various duty stations and for all duty stations combined (Navy norm).

Results

Athletic, automobile, and motorcycle-related accidents accounted for 63% of all off-duty injury hospitalizations. Machinery, falls, and miscellaneous accidents were the three most frequent (59%) causes of hospitalization for on-duty personnel. An inverse relationship was observed between risk of injury and seniority; higher injury rates occurred in lower pay grades.

Only three causal factors (machinery, athletics, and falls) were responsible for significantly elevating on-duty injury rates among specific duty stations. Destroyer personnel had a significantly higher on-duty injury hospitalization rate from both machinery and fall-related accidents compared to the Navy norm. Replenishment (cargo handling) personnel had the highest hospitalization rate (Relative risk = 1.94), while shore-based personnel had the lowest rate (Relative risk = 0.75) for injuries caused by machinery. Shore-based personnel also had a significantly higher incidence of on-duty athletic injuries when compared to the Navy norm.

Conclusions

The results have indicated that risks of injury vary widely as a function of seniority, duty station, and duty status. The external causes of injury that were observed when comparing duty station categories strengthens the hypothesis that the shipboard environment is a major risk factor for accidents and injuries.

Hospitalizations for Accidents and Injuries in the U.S. Navy
II. External Cause of Accident, Duty Station Assignment, and Level of Seniority

INTRODUCTION

Previous research has shown that accidental injury hospitalization rates vary with occupation, duty status, and level of seniority [Ferguson, McNally and Booth, 1981a]. Anderson [1983] has shown that the differences in the angle of inclination of (gangway and accommodation) ladders and stairways aboard ship and their shoreside and domestic counterparts contributed to a significant number of slipping and falling accidents observed aboard British shipping vessels. This suggests that the "location of accident" may be an important variable in assessing the risk of accident-related hospitalizations for personnel assigned duty aboard U.S. Navy ships.

Military demographic variables, such as age, education level, length-of-service, and pay grade have also been shown to have a significant impact on overall accident rates [Ferguson, McNally, Booth, 1984; Gunderson, Rahe, Arthur, 1970; Pugh and Gunderson, 1975].

Recently, Helmkamp and Bone [1985] determined that conventionally powered Aircraft Carriers, Destroyers, and Replenishment ships were more hazardous for on-duty injuries than the rest of the Navy. While a few categories of external causes (land transport, falls/miscellaneous, athletics, and machinery) accounted for the majority (61%) of accident-related hospitalizations [Ferguson, McNally and Booth, 1981b], these factors have not been examined in relation to duty station assignment and level of seniority (pay grade) when the injury occurred.

In this study, accidental injury hospitalization rates were calculated for major operational, administrative, tactical, and support duty stations in the Navy, and then related to the specific external cause of the accident and to the individual's level of seniority at the time of hospitalization. These adjusted rates were used to identify high risk groups, thereby providing a basis for focusing accident prevention programs and medical resources where they are most needed.

This paper is the second in a series of reports that have examined accident and injury related hospitalizations among Navy enlisted personnel during the three-year period 1977-1979 [Helmkamp and Bone, 1985].

METHODS

The method for obtaining population data for the total Navy as well as for the major sea and shore-based duty stations is described in the first report of this series [Helmkamp and Bone, 1985]. Specifically, medical data for all active duty enlisted personnel were obtained from computer files maintained at the Naval Health Research Center, San Diego. Participants in the study included all male enlisted personnel who had an accident during the three-year period 1977-1979 (N = 21,925) that resulted in hospitalization, a Medical Board, a Physical Evaluation Board, or death. The term "hospitalization" will be used throughout this report to collectively describe these outcome events. Hospitalizations were considered to be due to an accident or injury if the diagnoses were included in the "Accidents, Poisonings, and Violence" category (Codes 800-999) of the International Classification of Disease, Adapted for Use in the United States, Eighth Revision. Self-inflicted, combat, or assault-related injuries were not included. Additional clas-

sifications were used to further describe individual injuries: 1) type of duty station to which an individual was assigned at the time of injury, 2) external cause of injury (when it could be determined), 3) seniority (reflecting the pay grade that was reported on medical records at the time of hospitalization), and 4) duty status when the injury occurred--on-duty, off-duty, or duty status not specified.

Table 1 identifies twelve broad categories of external cause ("E" codes) that may contribute to accidental injury hospitalizations. The use of these E codes provides a supplemental classification of environmental events, circumstances, and conditions as the primary causes of an accident or injury.

Table 1. External Cause of Injury

1) Air Transport[a]
2) Land Transport-Automobile, includes military and civilian owned[a]
3) Land Transport-Motorcycle, includes military and civilian owned[a]
4) Other Land Transport, includes tractors, self-propelled guns, trains, etc.[a]
5) Water Transport, including all injuries associated with hazards inherent in that means of transporting, such as machinery, falls, water tight doors aboard ship[a]
6) Athletics, including physical training
7) Guns and Explosives
8) Machinery, tools, and selected agents, including electrical current, cutting or piercing instruments, and falling objects
9) Poisoning and Fires, including poisoning by industrial toxic substances, either by ingestion, inhalation, or skin contact; insect and snake bites; hot or corrosive substances
10) Environmental Factors, including excessive heat or cold
11) Falls
12) Miscellaneous, including twisting, turning, lifting without fall; hanging/suffocation (not self-inflicted)

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[a] Definition of Transport Accidents: The three major categories of this causative agent include those mishaps which are specifically defined as being accidents in air, land, or water transport. The specific definition requirement is that the mishap must have occurred during the use of these means in the transportation of personnel or material, and that its occurrence must have been a result (or presumed result) of the hazards related to such use. Both of these criteria must be met for the accident to be classified in one of these three categories [Beck, 1979].

The estimate of the population at risk for each of the duty stations was based on the average personnel strength for five quarterly reporting periods (December of the previous year, March, June, September, and December) during each year. A listing of the various duty stations and their average annual population at risk was provided in the first report of this series [Helmkamp and Bone, 1985].

Injury-related hospitalization rates by external cause were computed by taking the three-year annual average number of injuries attributed to the specific cause and dividing it by the average population for the duty station of interest. These rates were adjusted for age and pay grade to allow for more valid comparisons between groups and to decrease potential bias [Lilienfeld and Lilienfeld, 1980].

Relative risks were computed using the total Navy rate as the standard rate compared to a specific duty station's rate. Statistical significance was assessed using methods outlined by Dever [1984].

RESULTS

Frequencies, percentages, and rankings of external cause factors by duty status for accidental injury-related hospitalizations, are shown in Table 2. Cause of injury was unspecified for 23% of the hospitalizations; therefore, these cases were excluded from all calculations and rankings.

Table 2. Distribution of Accidental Injury Hospitalizations by External Cause of Injury and Duty Status for CY 1977-1979

	Combined[a]			On-Duty			Off-Duty		
External Cause	Number	Percent	Rank	Number	Percent	Rank	Number	Percent	Rank
Athletics	973	17.3	1	85	6.9	6	845	21.0	2
Auto related	945	16.8	2	31	2.5	9	850	21.1	1
Motorcycle related	906	16.2	3	17	1.4	11	837	20.8	3
Falls	750	10.3	4	263	18.1	2	434	10.8	4
Machinery	617	11.0	5	297	24.3	1	281	7.0	6
Miscellaneous	539	9.6	6	167	13.7	3	332	8.3	5
Poison/Fire	233	4.1	7	90	7.4	5	109	2.7	8
Other Land Transport	185	3.3	8	17	1.4	12	158	3.9	7
Water Transport	166	3.0	9	130	10.6	4	30	0.7	11
Guns/Explosives	123	2.2	10	24	2.0	10	90	2.2	9
Environmental	96	1.7	11	39	3.2	8	49	1.2	10
Air Transport	75	1.3	12	63	5.1	7	11	0.3	12
Total	5608	100.0		1223	100.0		4026	100.0	

[a]Includes duty status "unspecified"

Athletic, automobile, and motorcycle-related injuries accounted for 63% of off-duty accident-related hospitalizations, but less than 11% of on-duty hospitalizations. Machinery, falls, and

miscellaneous accidents were the three most frequent (59%) external causes of injury for on-duty accidents.

The importance of seniority to the risk of accidental injury is illustrated by Figure 1 which shows higher injury rates occurring for lower pay grades. It should be noted that the E1 category contains those personnel undergoing or who had completed recruit training as well as others who may have been administratively reduced in rate.

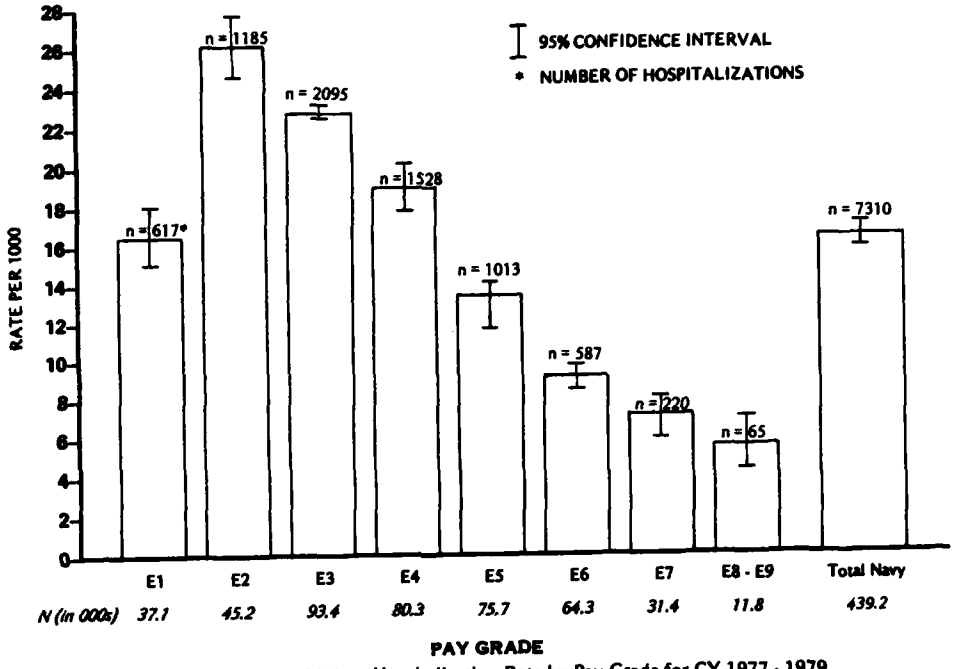

Figure 1. Accidental Injury Hospitalization Rate by Pay Grade for CY 1977 - 1979.

Although non-rated personnel (E-1 through E-3) make-up 40% of the total Navy enlisted strength, this group accounted for more than one-half (53.3%) of the total accident-related hospitalizations. The apprentice pay grade (E-2) had nearly five times the risk of injury compared to Senior and Master Chief Petty Officers (E-8 and E-9).

The leading external causes of accident-related hospitilizations were not the same across all pay grades. The top three causes of hospitalizations for E-1 personnel (in all duty status categories) were falls, athletics, and machinery. The majority of injuries for the rest of the pay grades were caused by athletic, automobile, and motorcycle accidents. The majority (80%) of accident-related hospitalizations in pay grades E-2 through E-9 occurred off-duty, while the proportions of hospitalizations for the E-1 pay grade were .49 for on-duty and .51 for off-duty.

Age-adjusted accidental injury hospitalization rates and relative risks were computed by external cause and duty station assignment for the five leading causal factors (combined duty status): athletics, automobiles, motorcycles, falls, and machinery. For athletics, only personnel in the All Other (Shore) category showed a significantly elevated rate of hospitalization. The

incidence of automobile-related injuries did not differ appreciably among duty stations. Repair ship personnel had an elevated risk for motorcycle-related injuries and Destroyer personnel were the only group with an elevated risk of injury from falls. Amphibious, Destroyer and Construction Battalion personnel had significantly elevated rates of injury resulting from machinery-related mishaps.

Table 3 summarizes the rates for on- and off-duty hospitalizations by causative agent for specific duty assignments. Duty stations whose personnel were found to have statistically significant differences in rates are presented.

Table 3

Accidental Injury Hospitalization Rates and Relative Risks by Duty Station, Selected External Causes, and Duty Status for CY 1977-1979

Duty Station Assignment	On-Duty			Off-Duty		
	Rate[b]	Relative Risk	Sign.	Rate[b]	Relative Risk	Sign.
Machinery						
Total Navy[a]	6.8	1.00	--	6.4	1.00	--
Replenishment	13.2	1.94[c]	p<.01	5.1	0.80	N.S.
Destroyer	10.0	1.47[c]	p<.05	7.8	1.22	N.S.
Nuclear Submarine	7.7	1.13	N.S.	2.6	0.41[d]	p<.05
All Other (Shore)	5.1	0.75[d]	p<.01	6.8	1.06	N.S.
Athletics						
Total Navy	2.0	1.00	--	19.3	1.00	--
Destroyers	1.0	0.50	N.S.	24.4	1.26[c]	p<.05
All Other (Shore)	2.8	1.40[c]	p<.05	20.9	1.08	N.S.
Falls						
Total Navy	6.0	1.00	--	9.9	1.00	--
Destroyers	8.7	1.45[c]	p<.05	13.1	1.32[c]	p<.05
Motorcycles						
Total Navy	3.8	1.00	--	19.1	1.00	--
Repair	0.0	--	--	26.5	1.39[c]	p<.01

[a]All male enlisted personnel

[b]Rates are per 10,000

[c]Significantly greater than Navy norm

[d]Significantly lower than Navy norm

Only three causal factors (machinery, athletics, and falls) were responsible for significantly elevated on-duty injury rates among Replenishment, Destroyer, and shore personnel. Replenishment (cargo handling) personnel, with the highest machinery related on-duty hospitalization rate, had nearly twice the risk of injury as the Navy norm. Destroyer personnel had significantly higher on-duty machinery and fall-related injury rates, while the All Other (Shore) category was the only group with a significantly reduced on-duty machinery-related hospitalization rate when compared to the Navy norm. Shore-based personnel also had a significantly higher incidence of on-duty athletic injuries when compared to the total Navy.

DISCUSSION

Several specific differences were noted when accident-related hospitalizations were compared across various duty status, external cause, and pay grade categories.

Falls, athletics and machinery-related injuries were the leading causes of hospitalization among the lowest rated personnel (E1s), whereas athletics, automobile and motorcycle-related accidents and injuries were the leading causes among the other pay grades (E2-E9). The lack of a significant difference between the proportion of hospitalizations for E1s on- and off-duty compared to the large difference noted for E2 - E9 personnel reflects primarily the restrictive conditions of the E1 pay grade. Recruits are typically in a confined and administratively controlled environment; daily activities are highly regimented throughout the duration of their indoctrination training with restrictions placed on their liberty. On the other hand, personnel in the more senior pay grades exercise much greater control over their free time. The steadily declining injury rates for E4-E9 personnel suggests that experience and familiarity with hazards in the workplace may reduce accidents. These findings agree with those of Ferguson et al, *[1981a], where an inverse relationship* between risk of injury and seniority also was observed. There may be inherent differences in the levels of environmental risk factors to which personnel are exposed. Since more senior personnel usually hold supervisory positions that are oriented towards less hands-on, labor intensive tasks, their exposure to risk factors would be arguably less than for younger, unrated personnel. Comparisons of injury hospitalization rates between pay grade levels should therefore be interpreted accordingly.

Almost 40% of all on-duty hospitalizations were caused by either machinery or fall-related injuries. Since only Replenishment ship and Destroyer personnel had significantly higher on-duty hospitalization rates from these two causes, it should be possible to greatly reduce injuries by initiating a comprehensive hazard awareness program, emphasizing fall and machinery-related accident prevention, aboard these ships.

These same causes contributed very little to rates observed off-duty, where more than 70% of total Navy injuries resulting in hospitalizations occurred. The off-duty environment is generally outside direct supervisory control; therefore, different methods of insuring compliance with safety regulations and preventive measures may be required.

It is interesting to note that none of the three leading external causes of accident-related hospitalizations occurring off-duty were the same for hospitalizations occurring on-duty. This suggests that the different environments encountered while on- or off-duty may have contributed

directly to the frequency, cause, and type of injury that occurred. This is not surprising, especially in a shipboard environment, where a complex array of habitability and work milieus present a broad range of biological, chemical and physical stressors to which personnel are continuously exposed.

The study by Ferguson et al, [1981b] represented the first analysis of Navy accidental injury hospitalization data in terms of cause and type of injury. Ferguson concluded that a small number of causes and types of injuries were involved in the great majority of accidents. Since there was an overlap in study periods for the Ferguson investigation (1974-78) and our own study (1977-79) similar conclusions in our study were not surprising. The present study, however, expanded the Ferguson causal analysis to include a more detailed investigation of accident-related hospitalizations to determine if rates varied by external cause for duty station and duty status.

Lugg [1984] recently indicated that hospital records in the United States routinely code for the "nature of injury" (type of injury or diagnosis) but, unfortunately, do not code for the external cause of injury (E codes). The experience from our study indicates that more than 75% of the accident-related hospitalization records, during the three-year study period, reported use of the International Classification of Disease "E" codes. Use of these codes in epidemiologic research allows a more complete assessment of risk and exploration of preventive measures.

CONCLUSIONS

The purpose of this study was to further examine accident and injury-related hospitalizations among male Navy enlisted personnel to determine if the type and cause of injury and the seniority of the individual, at the time of hospitalization, could help explain the risk differential observed across duty stations.

Our results have indicated that risks of injury vary widely as a function of seniority, duty station, and duty status. Although nearly one-quarter of the Navy's 1977-79 accident-related hospitalizations did not have the cause of injury specified, for those that did, the external causes of injury that were observed when comparing duty station categories strengthens the hypothesis that the shipboard environment is a major risk factor for accidents and injuries.

The next report in this series will address temporal factors that may be associated with the occurrence of accidents. Does time in assignment (time at duty station when accident occurred) affect an individual's risk of injury and subsequent hospitalization?

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An epidemiological analysis of accident-related hospitalizations was conducted to determine if risk varied by external cause, seniority, or duty station and then for selected causes and groups, whether the risk varied by duty status (on- or off-duty). All male enlisted personnel who had an accident that resulted in a hospitalization during the period 1977-1979 were included in the study (N = 5608). By using ICDA external cause codes it was determined that athletic, automobile, and motorcycle-related accidents accounted for 63% of all

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off-duty injury hospitalizations. Machinery, falls, and miscellaneous accidents were the three most frequent (59%) causes of hospitalization for on-duty personnel. An inverse relationship was observed between risk of injury and seniority; higher injury rates occurred in lower pay grades. Destroyer personnel had a significantly higher on-duty accidental injury hospitalization rate from machinery and fall-related accidents compared to the total Navy. Replenishment ship personnel had the highest hospitalization rate (Relative Risk = 1.94), while shore-based personnel had the lowest rate (Relative Risk = 0.75) for injuries caused by machinery. These results indicate that risk of injury among Navy enlisted personnel varies widely as a function of seniority, duty station, duty status, and contributing cause, strengthening the hypothesis that the shipboard environment is a major risk factor for accidents and injuries.

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